NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER
LANGLEY STATION
HAMPTON, VIRGINIA

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before
Hampton Roads Section
of
American Institute of Aeronautics and Astronautics
Hampton, Virginia
March 16, 1965

ADVANCED RESEARCH AND TECHNOLOGY IN THE AEROSPACE PROGRAM

I appreciate the opportunity to meet with my associates and friends in the Hampton Roads Section of the American Institute of Aeronautics and Astronautics to discuss the importance of advanced research and technology to the success of the nation's aerospace efforts. I plan to include the Langley Research Center as a focal point for much of my discussion. As you know, it happens to be the Center with which I am most familiar, and I recognize that the majority of us here tonight have more than a passing interest in what goes on there. But my principal reason is that Langley has played a pioneering role in the advancement of flight for nearly half a century, extending from the era of 100-mph flying crates to the challenges of the space age, building a foundation that is continually being deepened and broadened by basic scientific research.

The importance of advanced research and technology in the attainment of difficult aerospace goals has been convincingly proved by the history of flight. Many examples can be cited to illustrate this contention, but perhaps one of the most appropriate concerns the Wright Brothers — whose practical achievements in first lifting man from earth in a powered, heavier-than-air machine were made possible by their own activity in the field of basic research. Orville Wright commented after the flights at Kitty Hawk that, "except for what we learned from our wind tunnel experiments in 1901, we never could have built wings that would lift the machine and pilot with the amount of motor power then available." Incidentally, the first powered flights of the Wright Brothers were made in an airplane with a four-cylinder engine which developed only 13 horsepower.

For many years after the pioneering flights of the Wright Brothers, the development of the airplane in the land of its birth was dependent largely upon the efforts of amateur inventors – many of them working independently. But if there was U. S. apathy toward the need for a concerted effort in advanced research and technology in the field of the flight sciences, there was a quick recognition in

Europe of the potential benefits from aeronautical laboratories staffed by competent engineers and scientists. Not long after the Kitty Hawk flights, France, Germany, Russia, Italy, and a comparative late-comer, Great Britain, each instituted a national program of aeronautical research. One result was that when World War I began in 1914, the United States had 23 airplanes as compared to a combined total of about 3600 in France, Germany, Russia, and Great Britain. U. S. aircraft played a relatively unimportant role in World War I.

The need to enhance the United States' position in aeronautics was realized by some of our more farsighted citizens. Through their efforts and influence, Congress established in March 1915, 50 years ago this month, the National Advisory Committee for Aeronautics. Two years later, the NACA succeeded in establishing the Langley Research Center as a national laboratory created to study the problems of flight with a view to their practical solution. Langley, which began almost immediately to help lay the foundation of modern aerospace science in this country and thus recover lost ground, has been concerned with basic and applied research in its subsequent 48-year history.

Langley's first two decades were marked by a steady growth in laboratory facilities and complement. An effective pattern of operation was developed during these years consisting of a close cooperation of effort with the other branches of the Government and industry involved in the development of aircraft. The research capabilities were closely coordinated with the development requirements so that in the face of European competition the United States attained a position of preeminence in aircraft development. Great progress was made in achieving aerodynamic efficiency by new developments in the cooling of engines, refinements in propeller design, significant advances in airfoils, greater knowledge of the proper location of engines in relation to the fuselage and wings, and more thorough understanding of the means for increasing aircraft speed by careful attention to all external details of the shape. Many advances were made in understanding the problems of stability and control of aircraft so as to achieve satisfactory handling qualities at higher and higher speeds. The structural efficiency of aircraft was improved as a result of theoretical and laboratory studies of the problems in this area of aeronautics. Research on seaplane hulls resulted in major improvements in the design of seaplanes during this period.

Near the end of the '30's the U. S. position was threatened by an accelerated research and development activity in Germany just prior to World War II. This challenge was met by a major expansion of NACA facilities that took place in the following few years. At

Langley, the expansion was marked by the development of the so-called West Area, where most of our research facilities are now located. At the same time, plans were made by the NACA for two new research centers, the Lewis Research Center at Cleveland, Ohio, and the Ames Research Center at Moffett Field, California. Early in the '40's the Langley staff which was engaged in propulsion research moved to Lewis and other key personnel were selected to transfer from Langley as the nucleus of a staff to form the new Ames Research Center.

During World War II the NACA facilities were devoted primarily to improving the aircraft designs that were already in hand rather than looking farther into the future. At the end of this period, however, attention was again directed to research that would lay the foundation for major advances in aircraft performance through the transonic range and into the supersonic regime of flight. In pursuit of this objective during the middle '40's, Langley developed a program of flight research with rocket-powered models and established the Wallops Island facility for carrying out this program. At about the same time, we also initiated studies that resulted in the manned research airplane program and the establishment of the Flight Research Center at Edwards, California. Langley managed the Flight Research Center until 1953 and the Station at Wallops Island until 1959. These two stations have continued to grow in fulfillment of the purpose for which they were established and, of course, Langley has continued to expand its research facilities. We continue to utilize Wallops Island very extensively for carrying out flight research programs with rocket-powered models, including the Scout vehicle which we developed. We still collaborate closely in the flight programs being carried on at Edwards and played a key role in the development of the X-15 research aircraft which, it is interesting to note, entered its sixth year of powered flight in 1964 with a total of more than 4 hours of flight above Mach No. 3, more than 2-1/2 hours above Mach No. 4, more than 40 minutes above Mach No. 5, and 11.6 seconds above Mach No. 6.

Throughout the years, as a research laboratory devoted to aeronautics during the first years and now aeronautical and space research, we have helped lay the foundation for much of this country's aerospace flight progress. It is characteristic of this role that we collaborate with and work closely with others who have the responsibility for the development of major aircraft and space vehicles and their operation. We work closely with the other parts of our own organization having the responsibility for major flight missions and, in fact, gave birth to the scientific effort which became the Mercury project when the NASA was first established in 1958. We work closely with the military organizations in support of their responsibilities for development of aircraft and space vehicles, and assist industry in carrying out its contractual obligations in this regard. We assist the Federal Aviation Agency in carrying out its role and are heavily involved in supporting the proposed development of a supersonic commercial air transport.

The program of advanced research and technology has an important and unique responsibility in the national aeronautics and space effort. While it does not bear responsibility for direction of the major manned and unmanned flight missions, it does initiate pioneering programs and projects in science and technology to further airborne and space flight. It plays an important role in establishing the feasibility of undertaking the future major missions in space as well as laying a broad foundation for the development of future flight vehicles with superior performance. Realism in the planning of future missions is heavily dependent, from two standpoints, on a broad and continuing program of basic and applied research. First, such a program is required to assist in establishing the basic feasibility of technical concepts applicable to proposed missions – such as the demonstration through extensive research of the aerodynamic advantages of variable sweep as incorporated in the F-111 advanced fighter aircraft. Second, it must be present in a continuing and supporting role to provide the detailed clarification of technology needed to solve the technical problems that arise throughout the execution of the mission or the development of specific vehicles. Here again, the F-111 is a good illustration – since research centers contributed technical advice and assistance and 11,000 hours of wind-tunnel and laboratory test time during the detailed development of the aircraft.

Up to now I hope I have given some indication of the character and responsibilities of a national laboratory – devoted to advanced research and technology in support of national objectives – and working in close collaboration with others to achieve these objectives. I doubt that anyone will quarrel with the need for a research program to serve such a purpose. I think, however, another lesson has been learned, and that is the effort should be a continuing one, pursued with the support and foresight necessary to give the lead time required for the major missions such a program supports. From a late start in 1917, we were eventually able to recover the lost ground and attain a position of preeminence. Fortunately, as we approached the World War II period, the necessary action was taken to expand our facilities so that our position was not lost for some years. The lesson was soon forgotten, however, and it took the shock of the Russian sputnik in 1957 to wake us up. Sputnik stimulated the action that would properly support a program to put us back on the road toward preeminence in an area where we had failed to retain our national position of leadership. Many people in this country were shocked to learn that under another form of government a country many believed to be backward had actually developed an area of technical competence exceeding our own. We are still behind the Russians in achievements in manned space flight, but are well on the way toward establishing preeminence in that area.

The universal attention given to achievements in space shows that, in this age, an outstanding demonstration of technical competence by a nation has become a symbol of international prestige and world leadership. The scope of the effort in this field is very large and has an important bearing on our economic status. The Federal Government is investing close to $15 billion a year for general research and development – providing support for a variety of scientific endeavor vital to the welfare of all the people of the United States. While development activities claim the major share of these allocations, basic research is a significant part of the Federal Government's over-all effort.

NASA, whose budget represents about one-third of this $15 billion figure, contracts out more than 90 percent of its research and development work. Over 1,600 manufacturing firms have held prime contracts of over $25,000 and about 20,000 firms have worked under prime or subcontracts. Surveys made by 12 major prime contractors disclosed 3,000 subcontracts of over $10,000 to subcontractors located in all 50 states. During slightly over 6 years of operation, NASA contracts have totaled more than $13 billion, adding great strength to the country's industrial base. In fact, industrially speaking, research and development is described as the biggest of the nation's new big businesses. Langley's aerospace activities are national in scope. In an average year, we have about 25,000 procurement actions — and deal with about 4,500 contractors located throughout the United States. In addition, Langley carries on cooperative programs with about 70 colleges and universities.

While our own efforts as a scientific research center of the Federal Government are directed toward aeronautics and space flight, it is worthwhile to note what the President of the United States said in a speech to the National Industrial Conference Board in Washington, D. C., on February 17 of this year. I quote the President as follows:

> "All we have wrought in the 20 years since World War II must be done again — and more — in the 20 years that are ahead. By 1985, our Gross National Product must more than double to a rate of one and a half trillion dollars. In the next

20 years our job supply must increase nearly half again — to 100 million. Our population in 1985 will exceed 266 million — and three-fourths of that number will be housed and fed and employed and schooled and transported and protected in fewer than 200 metropolitan cities.

"So we shall be not only a highly urbanized people but also the most youthful nation in all the West. Already our average age is dropping one year every year. One-fourth of all Americans are in classrooms each school day.

"By 1985, more than half the citizens of this country will be too young to have any memories of the great war or the great depression or the sources of the great debates which so shape and mold the national policies that we adopt.

"This season is profound for America. Our strong and our successful society is moving literally away from the environment which has nurtured us for 188 years and has nurtured those values which have made it strong and successful.

"We are thrust into a new environment which our technologies have allowed and have caused us to create. Our challenge is closely akin to that of Americans one hundred years ago who carried the values of our society into the new environment of our western frontiers." End of the quotation from the President's speech.

At the Langley Research Center, we have substantial resources and capabilities that, I believe, are being directed usefully to meet some of the challenge in the President's statement. We have about 4,300 people and a plant investment of about a quarter of a billion dollars. We are attempting to retain our in-house competence for research in aeronautics and space while dealing effectively with the greatly expanded program involving efforts of others working with us through contracts and other forms of agreement. Scientific knowledge is being acquired at an unprecedented rate. The general competence of the country is being rapidly increased. As regards the advancement of technology, the major problem is the rapid assimilation and application of this increasing technology to meet the challenges implied in the President's statement.

This brings me to a final point that I would like to discuss — the responsibilities of engineers and engineering. By definition, engineering is the application of science. Engineers are thus the appliers of science. With the importance that technology plays in our general welfare and economic development, the responsibilities of engineers and engineering are very great. Historically, engineers have maintained that they were prepared to exploit natural resources and natural laws for the benefit of mankind. The scientist, while not opposed to worthy exploitations, has never claimed this responsibility, and neither has the other member of the team, the technician. This seems to leave the engineer an opening to reaffirm this responsibility and discover new ways to make his technical competence available to help decide what should be done rather than merely how it should be done. Professional societies such as the AIAA might do well to increase their interest in public affairs on a local level or on a state or national basis as the opportunity presents itself. By demonstrating a sense of responsibility and humane understanding along with technical creativity and the pursuit of engineering excellence, engineers in thousands of communities throughout the United States have it in their power to extend their influence and create a public image compatible with their true contribution to society. While winning increased respect among their neighbors, engineers — along with others who seek to improve the welfare of the communities in which they live — will feel the satisfaction of having accepted their total public responsibilities.

Thank you.